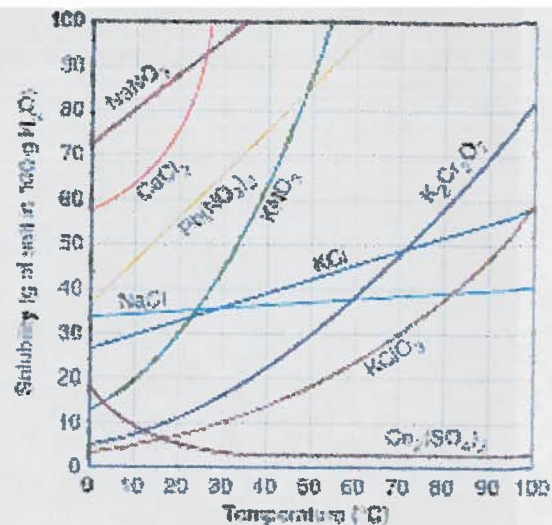
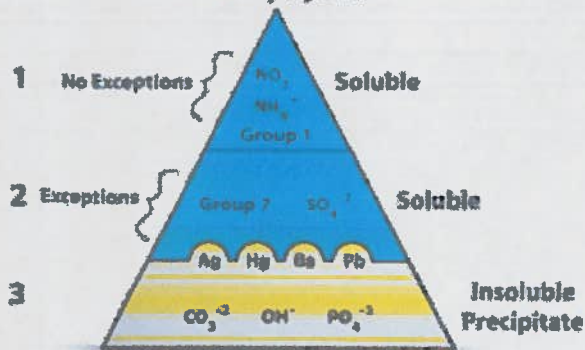
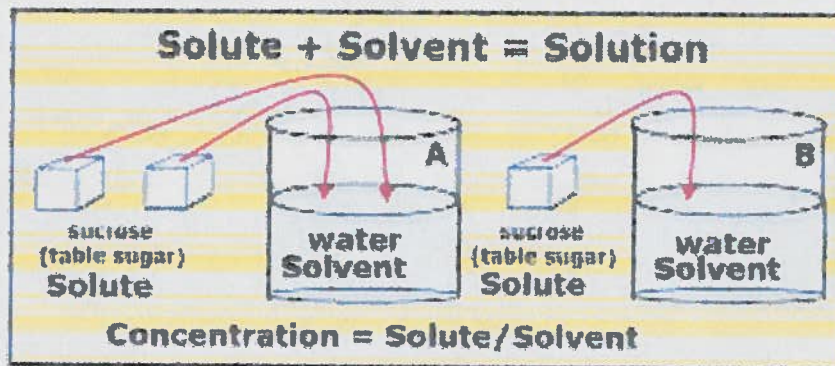


Top Down Solubility Pyramid



Unit 10: Solutions



Name _____ Per _____

Mendoza Chemistry
2014-15

Rm 323/326

www.wbamendoza.weebly.com

Solutions

SOLUBILITY is a measure of how much substance will dissolve in a certain amount of solvent at a given temperature.

Concentration tells you the strength of a solution

The amount of solute dissolved in a solvent is given in terms of concentration — this is just a measure of how "strong" or "weak" the solution is. Concentration is measured in four main ways:

1) Molarity (M) — this is the number of moles of solute dissolved in 1 liter of solution.

$$\text{molarity} = \frac{\text{moles of solute}}{\text{liters of solution}}$$

For example, if 0.5 moles of solute is dissolved to form 2 liters of solution, then the molarity is 0.25 M.

2) Percent by volume (% v/v) — this is the relative volume of solute to volume of solution.

$$\text{Percent by volume concentration} = \frac{\text{volume of solute}}{\text{volume of solution}} \times 100$$

For example, if you have 1 liter of solute dissolved to form 2 liters of solution, the percent by volume concentration is 50%.

3) Percent by mass (% m/m) — this is the relative mass of solute to mass of solution.

$$\text{Percent by mass concentration} = \frac{\text{mass of solute}}{\text{mass of solution}} \times 100$$

For example, if you have 1 gram of solute dissolved to form 10 grams of solution, the percent by mass concentration is 10%.

4) Parts per million (ppm) — this is the number of "parts" of solute for every million "parts" of solution.

$$\text{Parts per million (of solute)} = \frac{\text{mass of solute}}{\text{mass of solution}} \times 10^6$$

For example, if you have 15 grams of solute dissolved to form 1×10^6 grams (1000 kg) of solution, the parts per million of solute in the solution is 15 ppm.

Solutions can be unsaturated, saturated, or supersaturated

At a particular temperature, a solution can be classified in one of three ways:

UNSATURATED: a solution that can dissolve more solute without changing the temperature.

SATURATED: a solution that can't dissolve any more solute at that temperature — it's "full."

SUPERSATURATED: a solution that contains "too much" solute. This is an unstable state that you can get by cooling a saturated solution very, very slowly. If the temperature change is gradual enough, the solute will stay dissolved rather than dropping out of solution as it cools.

Solutes affect the melting and boiling points of a solution

1) If you add a nonvolatile solute to a solvent, the resulting solution will have different melting and boiling points than the original solvent.

A nonvolatile solute is one that does not evaporate with the solvent when the solution is heated.

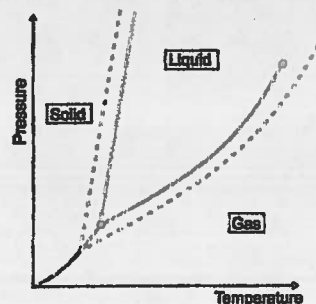
2) The melting point becomes lower.

3) The boiling point becomes higher.

4) The changes in melting and boiling points are proportional to the concentration of dissolved particles.

5) Ionic solutes have a greater effect than molecular solutes, because they ionize in solution, forming twice as many dissolved particles.

This is how a solute affects the phase diagram of the solvent. The dotted line represents the values for the solution.



Name _____ Date _____

Solutions Vocabulary

1. Boiling point
2. Molarity
3. Parts per million (ppm)
4. Percent by volume
5. Percent m=by mass
6. Saturated
7. Solute
8. Solution
9. Solvent
10. Supersaturated
11. Unsaturated
12. Vapor
13. Vapor pressure
14. Polar
15. Nonpolar

Unit 10: Solutions
10.1: Intro to Solutions

AIM:

• **Solutions**

• Most _____

▪ _____ = aluminum, gold, hydrogen

▪ _____ = salt water, air, mayonnaise

• Solutions _____

• Most _____

• A solution _____

• Homogenous _____

• Contain _____

• Spread _____

• Ex: salt water solution = NaCl stirred into water.
Ions of salt separate (Na^+ & Cl^-) and uniformly spread
throughout the water

• **Types of Solutions**

○ Solid _____

▪ Brass _____

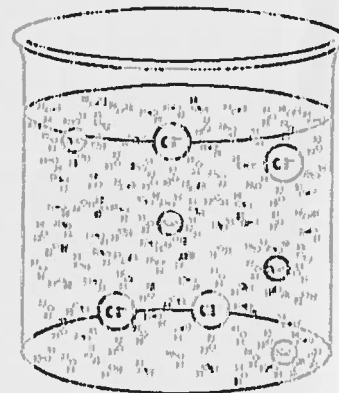
▪ Metals _____

○ Gases _____

▪ _____

○ Solid _____

▪ Most _____ Ex: _____



• **Parts of Solutions**

○ Solute: _____

○ Solvent: _____

▪ Water _____

• (aq) _____

• $\text{NaCl(s)} \rightarrow \text{Na(aq)} + \text{Cl(aq)}$

▪ Ex: NaCl dissolved in water

• NaCl = _____

• Water = _____

○ Once _____

▪ Liquid _____

▪ Light _____

• **Properties of Solutions**

○ Can have _____

▪ Copper _____

○ Do not _____

▪ Sodium _____

○ Dissolved _____

▪ Separate _____

• Boil _____

Regents Questions

- When a teaspoon of sugar is added to water in a beaker, the sugar dissolves. The resulting mixture is

- (1) A compound
- (2) A homogeneous solution
- (3) A heterogeneous solution
- (4) An emulsion

- A small quantity of a salt is stirred into a liter of water until it dissolves. In the resulting mixture, the water is

- (1) The solvent
- (2) The solute
- (3) Dispersed material
- (4) A precipitate

- A solution

- (1) Will separate on standing
- (2) May have color
- (3) Can be cloudy
- (4) Can be heterogeneous

- The process of recovering a salt from a solution by evaporating the solvent is known as

- (1) Crystallization
- (2) Filtration
- (3) Reduction
- (4) decomposition

Mixtures

Q1 Give a definition of a mixture.

Q2 Copy and complete these sentences about mixtures, using the options given in the brackets.

Mixtures are fairly (easy/hard) to separate.

The properties of a mixture are (completely different than/a mixture of) the properties of its separate parts.

Samples of mixtures (are always the same/may vary) in their properties.

Q3 Define a solution.

Q4 50 g of salt is dissolved in a container of water.

a) Name the solvent and the solute in this example.

b) The salt is ground into smaller particles.

What effect would you expect this to have on the rate at which the salt dissolves?

c) Name another factor you could change to make the salt dissolve more quickly.

Q5 A homogeneous mixture is a mixture in which the particles of one substance are evenly dispersed through the particles of another.

a) Give a definition of a heterogeneous mixture.

b) Give an example of a heterogeneous mixture of two liquids.

Q6 In the boxes below, draw diagrams using circles to represent atoms.



A pure liquid element



A heterogeneous mixture of two liquid elements



A homogeneous mixture of two liquid elements



A homogeneous mixture of two liquid compounds

At last, a nice easy page...

Questions on mixtures are a cinch compared to all those horrid formulas and calculations on the last page. Still, that's no excuse for slacking. The easy credits are worth just as much as the hard ones, so make sure you get every easy question 100% right...

Unit 10: Solutions
10.2: Solubility of Solutions

AIM:

• **Solubility Factors**

○ Some _____

▪ Example

• Coffee: _____

• **Solubility**

○ The amount of a _____

▪ Soluble

• Materials _____

• High _____

▪ Insoluble

• Materials _____

• Low _____

• **Factors Affecting Solubility**

○ Nature of solute and solvent

▪ Like _____

• Polar _____

• Nonpolar _____

▪ NaCl _____

• Sodium chloride _____

• Water _____

○ Positive and _____

▪ Na+ _____

▪ Cl- _____

▪ The attractive forces _____

▪ Ions stay _____

- Nonpolar solutes _____
 - Fat = _____
 - Water = _____
 - Attractive _____

- Fats will dissolve in _____
 - Forces _____

 - Grease _____
 - Soap _____
 - Grease _____

○ **Solubility Summary**

Solute Type	Nonpolar Solvent	Polar Solvent
Nonpolar		
Polar		
Ionic		

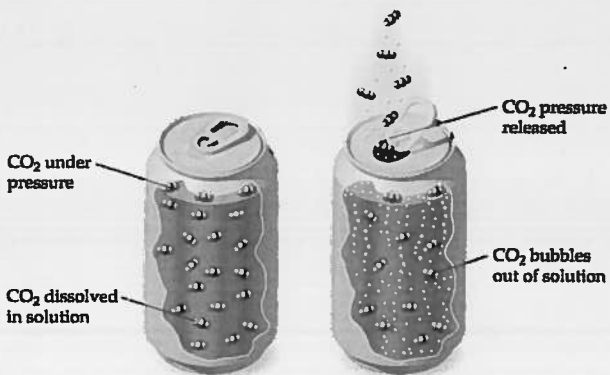
○ **Temperature**

- As temperature _____
 - Exception: _____
- As temperature _____
 - Ex: Soda _____

○ **Pressure**

▪ Pressure _____

▪ Pressure _____



• As pressure _____

• Ex: When _____

Regents Questions

- Nonpolar solvents will most easily dissolve solids that are
 - (1) Ionic
 - (2) Covalent
 - (3) Metallic
 - (4) Heterogeneous
- Under what conditions are gases most soluble in water?
 - (1) High temperature and high pressure
 - (2) High temperature and low pressure
 - (3) Low temperature and high pressure
 - (4) Low temperature and low pressure
- As the temperature of a liquid decreases, the amount of a gas that can be dissolved
 - (1) Decreases
 - (2) Increases
 - (3) Remains the same
- State the relationship between the solubility of sulfur dioxide gas and temperature.
- Describe the effect on the solubility of $\text{KNO}_3(\text{s})$ in water when the pressure is increased.

Unit 10: Solutions

10.3: Conditions of Solubility of Solutions

AIM:

o Looking at Solubility

o Table G Reference Tables

▪ Relationship _____

• Number _____

▪ Each line _____

o Table G - Solubility Curve Ditto

▪ What happens to the solubility of most solids as temperature increases?

• Most solids _____

▪ Not all of the solubility increases when temperature increases? What happens?

• Some solids _____

▪ What do you notice about three of the lines?

• Three lines _____

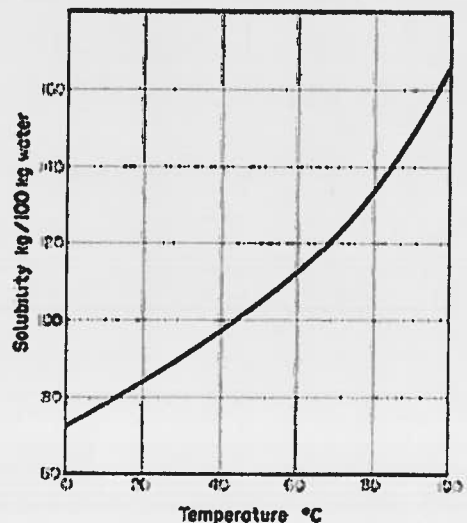
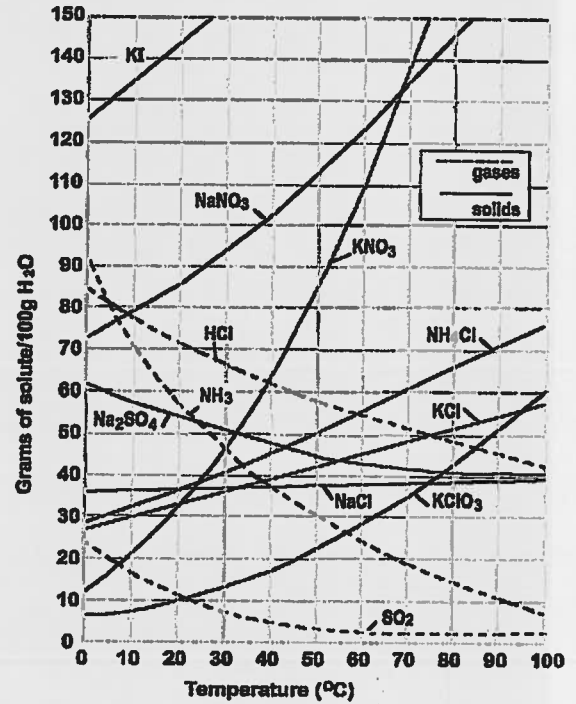
o Conditions of Solubility

A _____

B _____

C _____

D _____



- **Unsaturated** _____
 - Position _____
 - More _____
- **Saturated** _____
 - Position _____
 - No more _____
 - adding _____
 - If the temperature is _____
_____ =
 - Position _____
 - **Supersaturated**
 - Rarely, does the temperature of a solution decrease and crystals do not form and precipitate out
 - Solution _____
 - Position _____
 - More _____
 - **Dilute solution** _____
 - 5g of solute in 100g water
 - **Concentrated solution** _____
 - 80g of solute in 100g water

Solubility Tables - Table F

A reaction takes place _____

State whether the compound is soluble or insoluble in water

- | | | | |
|--------|---------------------|----------------------|----------------------|
| • NaCl | BaS | • Potassium chlorate | • Calcium sulfate |
| • AgCl | Ba(OH) ₂ | • Lithium chromate | • Ammonium carbonate |

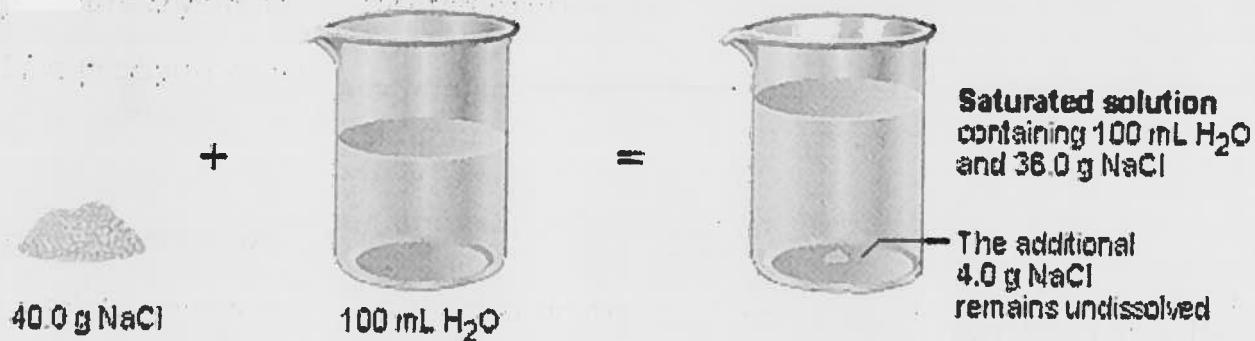
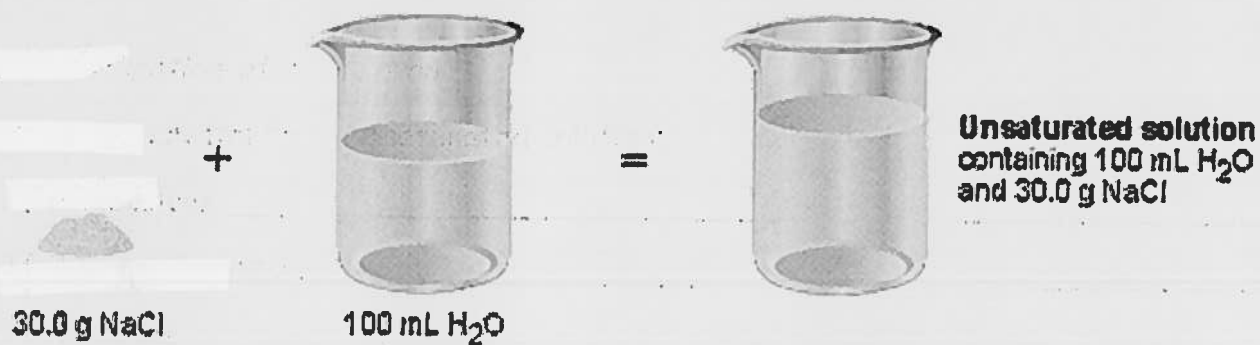
Determining Saturation of a Solution

- Adding a solute crystal to an unsaturated solution:

- If it dissolves _____
- If it precipitates out _____
- If it causes _____

- Adding a solute crystal to a saturated solution:

- If it precipitates out _____



- Adding a solute crystal to a supersaturated solution:

- If it _____

Regents Questions

- What happens when a crystal of a salt is dropped into an unsaturated solution of the same salt?
 - (1) Excess solute crystals form
 - (2) The crystals dissolve
 - (3) The crystal drops to the bottom, unchanged
 - (4) The solution becomes colorless

- What happens when a crystal of solute is dropped into a supersaturated solution of the salt?
 - (1) The crystal dissolves
 - (2) Excess solute crystals form
 - (3) The crystal drops to the bottom, unchanged
 - (4) The solution begins to boil

- Which substance increases in solubility as the temperature decreases?
 - (1) KClO_3
 - (2) NH_3
 - (3) KNO_3
 - (4) NaCl

- If solutions of barium nitrate and sodium sulfate are mixed and then poured into a filter, the solid remaining on the filter will be
 - (1) Barium nitrate
 - (2) Sodium nitrate
 - (3) Barium sulfate
 - (4) Sodium sulfate

- If 100g of water at 80°C contains 45g of KCl and 45g of NaNO_3 , the solution is
 - (1) Saturated with respect to both KCl and NaNO_3
 - (2) Saturated with respect to KCl and unsaturated with respect to NaNO_3
 - (3) Unsaturated with respect to both KCl and NaNO_3
 - (4) Supersaturated with respect to both KCl and NaNO_3

Table F Solubility Guidelines for Aqueous Solutions

Ions That Form Soluble Compounds	Exceptions
Group 1 ions (Li ⁺ , Na ⁺ , etc.)	
ammonium (NH ₄ ⁺)	
nitrate (NO ₃ ⁻)	
acetate (C ₂ H ₃ O ₂ ⁻ or CH ₃ COO ⁻)	
hydrogen carbonate (HCO ₃ ⁻)	
chlorate (ClO ₃ ⁻)	
perchlorate (ClO ₄ ⁻)	
halides (Cl ⁻ , Br ⁻ , I ⁻)	when combined with Ag ⁺ , Pb ²⁺ , and Hg ₂ ²⁺
sulfates (SO ₄ ²⁻)	when combined with Ag ⁺ , Ca ²⁺ , Sr ²⁺ , Ba ²⁺ , and Pb ²⁺

Ions That Form Insoluble Compounds	Exceptions
carbonate (CO ₃ ²⁻)	when combined with Group 1 ions or ammonium (NH ₄ ⁺)
chromate (CrO ₄ ²⁻)	when combined with Group 1 ions, Ca ²⁺ , Mg ²⁺ , or ammonium (NH ₄ ⁺)
phosphate (PO ₄ ³⁻)	when combined with Group 1 ions or ammonium (NH ₄ ⁺)
sulfide (S ²⁻)	when combined with Group 1 ions or ammonium (NH ₄ ⁺)
hydroxide (OH ⁻)	when combined with Group 1 ions, Ca ²⁺ , Ba ²⁺ , Sr ²⁺ , or ammonium (NH ₄ ⁺)

Overview:

This table is used to determine whether a particular compound is soluble or insoluble in water (aqueous solution). If an insoluble substance is formed in the reaction between two aqueous solutions of different salts (ionic compounds), it is called a precipitate and settles to the bottom of the container.

The Table:

The top chart shows ions that form soluble compounds with some exceptions noted. The bottom chart shows ions that form insoluble or nearly insoluble compounds with some exceptions noted.

Some general rules for solubility can be stated using information from this table:

- all compounds containing Group 1 ions are soluble in water.
- all compounds containing ammonium, nitrate, acetate, hydrogen carbonate, chlorate and perchlorate ions are soluble in water.

Be very careful to note the Exceptions columns. Many questions on the reagents involve these examples.

Additional Information:

- The halides are negative ions formed from Group 17 elements, known as the halogens.
- Since a relatively large amount of a soluble substance may be dissolved in a given amount of water, these solutions may be concentrated (strong solutions).
- Since only a small amount of an insoluble substance dissolves in a given amount of water, these solutions are dilute (weak solutions).
- Soluble ionic substances (salts) dissolved in water form solutions that readily conduct an electric current. They are referred to as strong electrolytes.
- The notation (s) following the formula of a substance indicates that the substance is a solid or insoluble in water (a precipitate) and the notation (aq) following a formula indicates an aqueous solution of that substance (soluble in water).
- When an insoluble substance (precipitate) is formed, it may be separated from the rest of the solution by the process of filtration. However, a soluble solute cannot be separated from the solvent by filtration.

Set 1 — Solubility Guidelines for Aqueous Solutions

1. According to Table F, which of these salts is *least* soluble in water?
- (1) LiCl (3) FeCl₂
(2) RbCl (4) PbCl₂ 1 _____
2. Which compound is insoluble in water?
- (1) BaSO₄ (3) KClO₃
(2) CaCrO₄ (4) Na₂S 2 _____
3. Which ion, when combined with chloride ions, Cl⁻, forms an insoluble substance in water?
- (1) Fe²⁺ (3) Pb²⁺
(2) Mg²⁺ (4) Zn²⁺ 3 _____
4. Based on Reference Table F, which of these saturated solutions has the *lowest* concentration of dissolved ions?
- (1) NaCl(aq)
(2) MgCl₂(aq)
(3) NiCl₂(aq)
(4) AgCl(aq) 4 _____
5. According to Reference Table F, which of these compounds is most soluble at 298 K and 1 atm?
- (1) AgCl (3) MgCrO₄
(2) AgI (4) PbCO₃ 5 _____
6. Based on Reference Table F, which salt is the most soluble?
- (1) AgI (3) ZnCO₃
(2) AgBr (4) K₂SO₄ 6 _____
7. Based on Reference Table F, which compound could form a concentrated solution?
- (1) AgBr (3) Ag₂CO₃
(2) AgCl (4) AgNO₃ 7 _____
8. Which compound when stirred in water will not pass through filter paper?
- (1) NaCl (3) Mg(OH)₂
(2) NH₄S (4) LiCl 8 _____
9. A student observed the following reaction:
- $$\text{AlCl}_3(\text{aq}) + 3\text{NaOH}(\text{aq}) \rightarrow \text{Al}(\text{OH})_3(\text{s}) + 3\text{NaCl}(\text{aq})$$
- After the products were filtered, which substance remained on the filter paper?
- (1) NaCl (3) AlCl₃
(2) NaOH (4) Al(OH)₃ 9 _____
10. Which barium salt is insoluble in water?
- (1) BaCO₃ (3) Ba(ClO₄)₂
(2) BaCl₂ (4) Ba(NO₃)₂ 10 _____

Base your answers to question 11 using the information below and your knowledge of chemistry.

In a laboratory activity, 0.500 mole of NaOH(s) is partially dissolved in distilled water to form 400. milliliters of NaOH(aq). This solution is then used to titrate a solution of HNO₃(aq).

11. a) Identify the negative ion produced when the NaOH(s) is dissolved in distilled water.

- b) Another student substituted Mg(OH)₂ for NaOH to make a solution to be use in this titration. Which compound would be more soluble?

Base your answers to question 12 using the information below and your knowledge of chemistry.

Calcium hydroxide is commonly known as agricultural lime and is used to adjust the soil pH. Before the lime was added to a field, the soil pH was 5. After the lime was added, the soil underwent a 100-fold decrease in hydronium ion concentration.

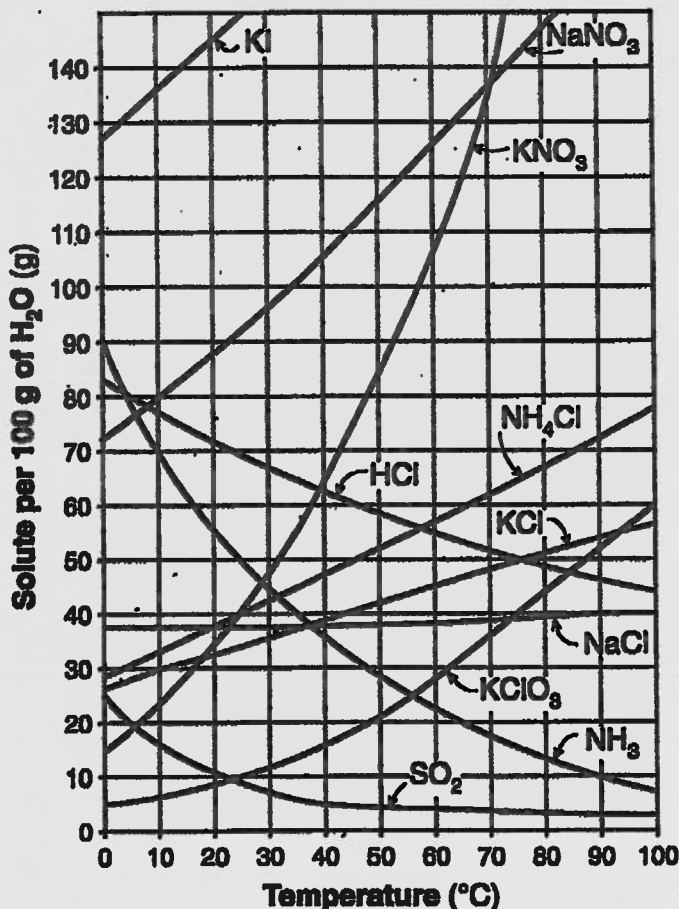
12. a) According to Reference Table F, is calcium hydroxide soluble in water?

- b) Identify another hydroxide compound that contains a Group 2 element and is soluble in water.

13. Give a statement on the solubility of Pb(C₂H₃O₂)₂.

Table G

Solubility Curves



Overview:

A solution is a homogeneous mixture of two or more substances. A solution has two components, the dissolved substance, called the solute, and the dissolving substance, called the solvent. In most solutions, the solvent is water and these are called aqueous solutions (aq). Temperature is one factor that determines the solubility of a solute in water. If the solute is a gas, pressure, as well as temperature, determines the solubility of that solute. The solubility of a solute as a function of temperature gives rise to a solubility curve.

The Table:

This table shows the mass of solute (dissolved substance), in grams (g), that can be dissolved in 100 g of H₂O as a function of temperature. From the intersection point of a solubility curve and a given temperature line, reading directly to the left gives the amount of that solute, in g, needed to saturate 100 g of H₂O at that temperature. A saturated solution contains the maximum amount of that solute that can be dissolved in 100 g of H₂O at that temperature. An equilibrium exists between dissolved solute and excess undissolved solute in a saturated solution.

Since the solubility of a solid solute increases with temperature, if the solution is cooled sufficiently, solute may start to drop out or precipitate out of solution. The resulting solution is then a saturated solution.

If the amount of solute dissolved in 100 g of H_2O is below the amount read from the solubility curve at that temperature, the solution is unsaturated.

If the amount of solute dissolved in 100 g of H_2O is greater than that amount read from the solubility curve at that temperature, the solution is supersaturated.

The graph shows that the solubility of solid solutes in H_2O generally increases as the temperature increases, while the solubility of gases (HCl , NH_3 , and SO_2) decreases as the temperature increases.

If the amount of H_2O is different from 100 g, the amount of solute needed to saturate that amount of H_2O will change accordingly. For example, if 50 g of H_2O is used, take half the amount of solute as read from the table. If 200 g of H_2O is used, take twice the amount of solute as read from the table.

Additional Information:

- A solution is homogeneous since the solute is distributed uniformly throughout.
- The dissolved solute in a solution cannot be separated from the solvent by filtration.
- A supersaturated solution is very unstable. Any disturbance, such as stirring or adding a crystal of the solute, will cause the excess solute to crystallize or drop out of solution, forming a saturated solution.
- The presence of solute raises the boiling point of the solvent and lowers the freezing point of the solvent.
- In using this table, be sure to use the correct solubility curve and the correct temperature line.
- Pressure has a negligible effect on the solubility of a solid in water. However, an increase in pressure increases the solubility of a gas in water and a decrease in pressure decreases the solubility of a gas in water.

Set 1 — Solubility Curves

1. Dilute, aqueous potassium nitrate solution is best classified as a

- (1) homogeneous compound
- (2) homogeneous mixture
- (3) heterogeneous compound
- (4) heterogeneous mixture

1 _____

2. According to Reference Table G, which substance forms an unsaturated solution when 80 grams of the substance is added in 100 grams of H_2O at $10^\circ C$?

- (1) KI
- (2) KNO_3
- (3) $NaNO_3$
- (4) NaCl

2 _____

3. A saturated solution of $NaNO_3$ is prepared at $60^\circ C$ using 100. grams of water. As this solution is cooled to $10^\circ C$, $NaNO_3$ precipitates (settles) out of the solution. The resulting solution is saturated. Approximately how many grams of $NaNO_3$ settled out of the original solution?

- (1) 46 g
- (2) 61 g
- (3) 85 g
- (4) 126 g

3 _____

4. One hundred grams of water is saturated with NH_4Cl at $50^\circ C$. According to Table G, if the temperature is lowered to $10^\circ C$, what is the total amount of NH_4Cl that will precipitate?

- (1) 5.0 g
- (2) 17. g
- (3) 30. g
- (4) 50. g

4 _____

5. Based on Reference Table G, what is the maximum number of grams of $KCl(s)$ that will dissolve in 200 grams of water at $50^\circ C$ to produce a saturated solution?

- (1) 38g
- (2) 42 g
- (3) 58 g
- (4) 84 g

5 _____

6. According to Reference Table G, which solution is saturated at $30^\circ C$?

- (1) 12 grams of $KClO_3$ in 100 grams of water
- (2) 12 grams of $KClO_3$ in 200 grams of water
- (3) 30 grams of NaCl in 100 grams of water
- (4) 30 grams of NaCl in 200 grams of water

6 _____

7. A mixture of crystals of salt and sugar is added to water and stirred until all solids have dissolved. Which statement best describes the resulting mixture?

- (1) The mixture is homogeneous and can be separated by filtration.
- (2) The mixture is homogeneous and cannot be separated by filtration.
- (3) The mixture is heterogeneous and can be separated by filtration.
- (4) The mixture is heterogeneous and cannot be separated by filtration.

7 _____

8. A solution that is at equilibrium must be

- (1) concentrated
- (2) dilute
- (3) saturated
- (4) unsaturated

8 _____

9. What occurs when NaCl(s) is added to water?

- (1) The boiling point of the solution increases, and the freezing point of the solution decreases.
- (2) The boiling point of the solution increases, and the freezing point of the solution increases.
- (3) The boiling point of the solution decreases, and the freezing point of the solution decreases.
- (4) The boiling point of the solution decreases, and the freezing point of the solution increases.

9 _____

10. According to Reference Table G, how many grams of KClO_3 must be dissolved in 100 grams of H_2O at 10°C to produce a saturated solution?

Base your answers to question 11 on the information below and on your knowledge of chemistry.

When cola, a type of soda pop, is manufactured, $\text{CO}_2(\text{g})$ is dissolved in it.

11. a) A capped bottle of cola contains $\text{CO}_2(\text{g})$ under high pressure. When the cap is removed, how does pressure affect the solubility of the dissolved $\text{CO}_2(\text{g})$?

b) A glass of cold cola is left to stand 5 minutes at room temperature. How does temperature affect the solubility of the $\text{CO}_2(\text{g})$?

c) In the accompanying space, draw a set of axes and label one of them "Solubility" and the other "Temperature."

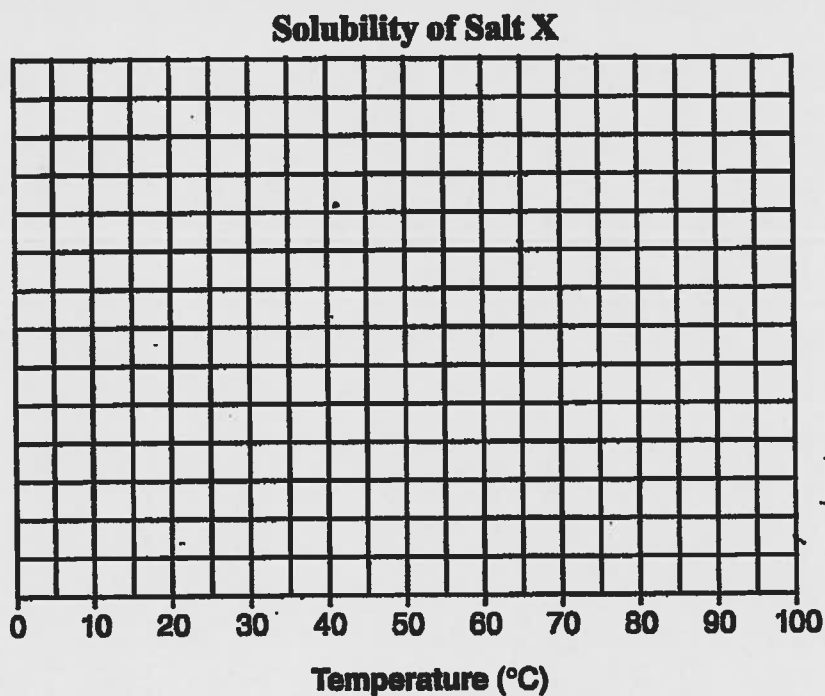
d) Draw a line to indicate the solubility of $\text{CO}_2(\text{g})$ versus temperature on the axes drawn in part c.

2. Given the data table below showing the solubility of salt X:

Temperature (C°)	Mass of Solute per 100 g of H ₂ O
10	22
25	40
30	48
60	107
70	135

a) Which salt on Table G is most likely to be salt X? _____

b) On the graph below, scale and label the y-axis including appropriate units.



c) Plot the data from the data table. Surround each point with a small circle and draw a best-fit curve for the solubility of salt X.

d) Using your graph, predict the solubility of salt X at 50°C. _____

e) If the pressure on the salt solution was increased, what affect would this pressure change have on the solubility of the salt?

Name _____ Date _____

Solubility Worksheet

1. Determine if the compound is soluble or insoluble in water:

NaOH

BaCO₃

(NH₄)₃PO₄

Ca(C₂H₃O₂)₂

AgI

Sr(NO₃)₂

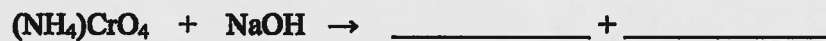
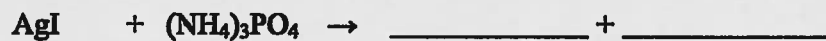
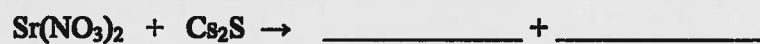
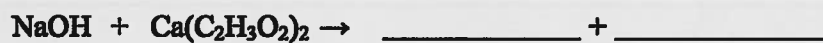
Cs₂S

(NH₄)CrO₄

KCl

NaCl

2. Determine what the products of the reaction will be and if a reaction will occur or not



Name _____

Date _____

Solubility Rules

1. In an aqueous solution of potassium chloride, the solute is
(1) Cl (2) K (3) KCl (4) H₂O
2. The attraction between water molecules and an Na⁺ ion or a Cl⁻ ion occurs because water molecules are
(1) linear (2) symmetrical (3) polar (4) nonpolar
3. Based on Reference Table F, which of the following saturated solutions would be the *least* concentrated?
(1) sodium sulfate (3) copper (II) sulfate
(2) potassium sulfate (4) barium sulfate
4. Based on Reference Table F, which salt is *least* soluble?
(1) FeCO₃ (2) Na₂CO₃ (3) BaCl₂ (4) CaCl₂
5. Based on Reference Table F, which of the following compound is least soluble in water?
(1) NaCl (2) Pb₂ClO₃ (3) Na₂CrO₄ (4) PbCrO₄
6. According to Reference Table F, which substance is most soluble?
(1) AgI (2) CaSO₄ (3) PbCl₂ (4) (NH₄)₂CO₃

Name _____ Date _____

Solubility Table Questions

1. Which compound's solubility decreases most rapidly as the temperature changes from 10°C to 70°C?
(1) NH_4Cl (2) NH_3 (3) HCl (4) KCl
2. A solution contains 14g of KCl in 100g of water at 40°C. What is the minimum amount of KCl that must be added to make this a saturated solution?
(1) 14g (2) 19g (3) 25g (4) 44g
3. Which salt has the greatest change in solubility between 30°C and 50°C?
(1) KNO_3 (2) KCl (3) NaNO_3 (4) NaCl
4. Which of the following substance is least soluble in 100g of water at 50°C?
(1) NaCl (2) KCl (3) NH_4Cl (4) HCl
5. How many grams of the compound potassium chloride (KCl) must be dissolved in 200g of water to make a saturated solution at 60°C?
(1) 30g (2) 45g (3) 56g (4) 90g
6. Which amount of a compound dissolved in 100g of water at the stated temperature represents a solution that is saturated?
(1) 20g KClO_3 at 80°C
(2) 40g KNO_3 at 25°C
(3) 40g KCl at 60°C
(4) 60g NaNO_3 at 40°C

Name: _____

What's this Stuff?

Big Picture: Bonding affects Solubility

Purpose of this Lab: test solubilities of four unknown substances.

Substance	A. Yellow	B. Dark green	C. Red	D. Light green
Appearance				
Sprinkle on water surface of a small beaker				
Drop in a small spoonful				
Remove from water and put substance into plastic dish				

Conclusions: Polar covalent substances will dissolve in polar covalent water
Non-polar substances will not dissolve or become wet in polar water.

Soluble or insoluble				
Homogeneous or heterogeneous mixture				
Bond Type				

Temperature: Hot water vs Cold Water. Add a spoonful of the Purple substance to two different beakers that contain different temperatures and observe.

What is the Relationship between Temperature and Solubility? _____

*** Clean up: DO NOT THROW INSOLUBLE SUBSTANCES INTO SINKS!

solubility curves

1. Based on Reference Table G, which of the following substances is most soluble at 60°C?

- (1) NH_4Cl (3) NaCl
 (2) KCl (4) NH_3

2. A student determined the mass, in grams, of compound X that would saturate 30. grams of water over a temperature range of 40.°C in 10.-degree intervals. The results are tabulated below.

Grams of Dissolved Compound X	Temperature of 30. grams of H_2O
2.0 g	10.°C
4.0 g	20.°C
8.0 g	30.°C
16 g	40.°C
32 g	50.°C

If this solubility trend continues, what is the total number of grams of compound X that will dissolve in 30. grams of water at 60.°C?

- (1) 16 (3) 48
 (2) 32 (4) 64

3. Which salt has the greatest change in solubility between 30°C and 50°C?

- (1) KNO_3 (3) NaNO_3
 (2) KCl (4) NaCl

4. According to the Reference Table G, which of the following substances is least soluble in 100 grams of $\text{H}_2\text{O}(l)$ at 50°C?

- (1) KCl (3) NH_4Cl
 (2) NaCl (4) HCl

5. A student obtained the following data in a chemistry laboratory.

Trial	Temperature (°C)	Solubility (grams of $\text{KNO}_3/100$ g of H_2O)
1	25	40
2	32	50
3	43	70
4	48	60

Based on Reference Table ^G~~F~~, which of the trials seems to be in error?

- (1) 1 (3) 3
 (2) 2 (4) 4

6. According to Reference Table G, a temperature change from 10°C to 30°C would have the *least* effect on the solubility of

- (1) NaCl (3) NH_3
 (2) KClO_3 (4) SO_2

7. As the temperature increases from 0°C to 25°C the amount of NH_3 that can be dissolved in 100 grams of water

- (1) decreases by 10 grams (3) increases by 10 grams
 (2) decreases by 40 grams (4) increases by 40 grams

8. According to Reference Table G, what is the approximate difference between the amounts of KClO_3 and KNO_3 soluble in 100 grams of water at 40°C?

- (1) 17 g (3) 47 g
 (2) 22 g (4) 64 g

9. Which of the salts listed below is most soluble at 60°C?

- (1) NaNO_3 (3) NH_4Cl
 (2) KNO_3 (4) KCl

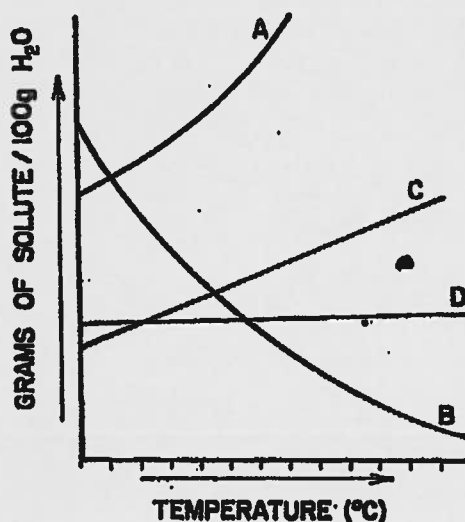
10. A student tested the solubility of a salt at different temperatures and then used Reference Table D to identify the salt. The student's data table appears below.

Temperature (°C)	g of salt per 10 g of water
30	1.2
50	2.2
62	3.0
76	4.0

What is the identity of the salt?

- (1) potassium nitrate (3) potassium chlorate
 (2) sodium chloride (4) ammonium chloride
11. According to Reference Table G, how does a decrease in temperature from 40°C to 20°C affect the solubility of NH_3 and KCl ?
- (1) The solubility of NH_3 decreases, and the solubility of KCl decreases.
 (2) The solubility of NH_3 decreases, and the solubility of KCl increases.
 (3) The solubility of NH_3 increases, and the solubility of KCl decreases.
 (4) The solubility of NH_3 increases, and the solubility of KCl increases.
12. Which compound decreases in solubility as the temperature of the solution is increased from 10°C to 50°C?
- (1) NH_4Cl (3) NH_3
 (2) NaCl (4) NaNO_3

13. The graph below represents four solubility curves. Which curve best represents the solubility of a gas in water?



- (1) A (3) C
 (2) B (4) D
14. Based on Reference Table G, what change will cause the solubility of $\text{KNO}_3(\text{s})$ to increase?
- (1) decreasing the pressure
 (2) increasing the pressure
 (3) decreasing the temperature
 (4) increasing the temperature
15. Which compound is *least* soluble in 100 grams of water at 40°C?
- (1) SO_2 (3) KClO_3
 (2) NaCl (4) NH_4Cl
16. Based on Reference Table G, what is the maximum number of grams of $\text{KCl}(\text{s})$ that will dissolve in 200 grams of water at 50°C to produce a saturated solution?
- (1) 38 g (3) 58 g
 (2) 42 g (4) 84 g
17. A change in pressure would have the greatest effect on the solubility of a
- (1) solid in a liquid (3) liquid in a liquid
 (2) gas in a liquid (4) liquid in a solid
18. The solubility of a salt in a given volume of water depends primarily on the
- (1) surface area of the salt crystals
 (2) temperature of the water
 (3) rate at which the salt and water are stirred
 (4) pressure on the surface of the water

19. At which temperature can water contain the most dissolved oxygen at a pressure of 1 atmosphere?

- (1) 10.°C
- (2) 20.°C
- (3) 30.°C
- (4) 40.°C

20. A gas is most soluble in a liquid under conditions of

- (1) high temperature and high pressure
- (2) high temperature and low pressure
- (3) low temperature and high pressure
- (4) low temperature and low pressure

Unit 10: Solutions
10.4: Concentration of Solutions

AIM:

- **Solutions**

- Homogenous mixtures _____
 - _____
 - Dilute: _____
 - Concentrated: _____
- There are different ways to express the concentration of a solution

- **Molarity**

- Measures the number of _____
- Table T CRT
 - Molarity (M) =

$$M = \underline{\hspace{10em}}$$

$$M = \underline{\hspace{10em}}$$

- What is the molarity of a solution that contains 4.0 mol of NaOH in 0.50 L of solution?

- What is the molarity of a solution containing 82.0 grams of $\text{Ca}(\text{NO}_3)_2$ in 2.0 liters of solution?

- **Percent by Mass**

- the _____
 - Similar to percent composition

Formula;

- What is the percent mass of sodium hydroxide if 2.50g of NaOH are added to 50.0 g of water?

Regents Questions

- ✓ What is the percent mass of NaOH is 12.5g is dissolved in 100. g of water?

- ✓ What volume of 3.0M HCl contains 0.20 mol of HCl?

- ✓ What is the molarity of a solution that contains 24g of NaNO₃ in 200mL of solution?

✓ How many grams of KNO_3 are present in 250mL of 2.0M potassium nitrate solution?

• **Percent by Volume**

• When _____

• Ex. Rubbing alcohol = 70% isopropyl alcohol by volume = the rest is water

• Percent by volume _____

Formula:

• What is the percent by volume of alcohol if 50.0mL of ethanol is diluted with water to form a total volume of 300.mL?

• **Parts per Million**

• Similar to _____

• Parts per million (ppm) _____

• Useful for _____

Formula:

- Approximately 0.0043 g of oxygen can be dissolved in 100.mL of water at 20°C. Express this in terms of parts per million.

- ***Preparation of a Known Concentration***

- What mass of sodium carbonate is required to prepare 2.00L of a 0.250 M sodium carbonate solution?

- **How to make that solution**

- Add 53.0 g of sodium carbonate to a 2.00L flask
- Add some distilled water and swirl until the solute is dissolved and mixed
- Fill with distilled water to the mark on the neck of the flask
- Stir again
 - It is easier to mix a solution when the flask is not full. Then fill the flask once it is mixed

- ✓ Describe now to prepare 500. mL of 4.0M NaOH(aq). Show any calculation.